SCIENCE

VOL. 99 FRIDAY, FEBRUARY 18, 1944 No. 2564

SCIENCE: A Weekly Journal devoted to the Advancement of Science. Editorial communications should be sent to the editors of SCIENCE, Lancaster, Pa. Published every Friday by

THE SCIENCE PRESS

Lancaster, Pennsylvania

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington 25, D. C.

GALACTIC EVIDENCES FOR THE TIME-SCALE OF THE UNIVERSE[1]

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AN important phase of modern astronomical research is concerned with the time scale of the universe, *i.e.*, with the specification of a natural unit of time in which it would be most convenient to describe the changing aspects of the astronomical universe. Stated in this manner, it is apparent that the solution to the problem of the time scale will not permit us (not at any rate in the first instance) either to "date" the present epoch in a "fundamental" calendar or to forecast with definiteness the "end." What it would allow us, however, is to specify an interval of time in which various aspects of the astronomical universe may be expected to change appreciably. Conversely, the solution to the problem of the time scale will ultimately depend on the study of a variety of different aspects of the universe and the establishment in each case of a time interval during which the aspect studied might change to an appreciable extent. And if such studies should lead us in most instances to time intervals which are of the same order of magnitude, it would not be unreasonable to attribute to a unit of time of this order of magnitude a fundamental significance. It would appear that this is the only manner in which a rational approach to the problem of the time scale can be made. However, in formulating the problem in this manner it is evident that a certain element of arbitrariness has been introduced into the discussion. But this is unavoidable and inherent in a problem in which the emphasis is on an order of magnitude and not on an absolute measure.

During the past twenty years many attempts have been made to establish a time scale in the sense de-

[1] Address given before the Philosophical Society of Washington on December 4, 1943.

scribed above.[2] But several of the arguments were inconclusive and in some cases even left room for violent disagreements. However, more recently, through the study of the dynamics of star clusters and the statistics of binary stars, some fresh evidences have come to light which bear on the question of the time scale. And it is the object of this report to describe the nature of these newer evidences.

To consider first the problem presented by galactic star clusters we shall take a concrete example and consider the case of the Pleiades. This star cluster includes some 200 stars in a spherical volume of radius about 3 parsecs (*i.e.*, approximately 10 light years). Moreover, a study of the internal motions in this cluster (made possible by some photographic plates of this cluster taken by Rutherford as early as 1870) has revealed that relative to the center of gravity the cluster members have a random motion with a root mean square velocity in the neighborhood of 500 meters per second. Since the average space density of stars in the general neighborhood of the sun is only about one star per ten cubic parsecs, it follows that in the Pleiades the star density is about twenty times that of the background "field" stars. Further, these field stars have motions relative to the center of gravity of the cluster of the order of 25 to 30 kilometers per second. Accordingly, it would appear that the Pleiades can be considered as an "isolated" stellar system, *i.e.*, practically uninfluenced by the field stars. And the question arises as to the permanence of such stellar aggregations. In order to answer this question we need to go into the dynamics of star clusters, and as this theory appears to have some general interest we may be allowed to elaborate on it a little.

First of all, it is evident that the gravitational force acting on a star is subject to fluctuations. The fluctuations arise simply as a consequence of the relative motions between the stars and the consequent changing complexion of the distribution of stars around any given one. In a general way it is clear that there will be practically no correlation in the forces (due to the near neighbors) acting on a star at two instants separated by an interval of the order required for an average star to traverse a distance equal to the average distance between the stars. For in this interval of time the complexion of stars around any given one may be expected to change radically. Now we may ask as to the effect of this fluctuating force on the motion of a star. In order to answer this question consider an interval of time of the order of a million years. During such an interval a star would have experienced some hundred elementary fluctuations, and a theoretical analysis shows[3] that the cumulative effect of such a large number of fluctuations has a two-fold consequence. First, it systematically decelerates the star in the direction of its motion and, second, superposes on this a random acceleration. More precisely, if we consider a time interval Δt long compared with the elementary fluctuations (but not so long that the increment in the velocity which the star may be expected to suffer is comparable with its initial velocity) then in the direction of its motion it will experience, on the average, a deceleration proportional to Δt. And the constant of proportionality, which may very well and, in fact, does depend on the magnitude of the initial velocity, may properly be called the *coefficient of dynamical friction:* it is dynamical because it operates only on stars in motion and it is friction because it acts as a brake on the motion of the star. Regarding the random part, it may be said that in consequence of this the mean *square* acceleration which the star may be expected to experience during a time Δt will also be proportional to Δt: the constant of proportionality which occurs here is sometimes called (for reasons which we shall not go into) the *coefficient of diffusion* in the velocity space.[4] The existence of these two terms in the acceleration experienced by a star may sound somewhat paradoxical. But it can be readily shown that these two terms (together with the relation which exists between them) are both necessary and sufficient for the maintenance of statistical equilibrium.

It will be noticed that the foregoing description of the effect of the fluctuating gravitational field on the motion of a star is very similar to the influence of the molecules of the surrounding liquid on the motion of suspended colloidal particles in the theory of the Brownian movement. Thus, in the latter theory, it is assumed that the colloidal particles experience both a dynamical friction (now given by Stokes's law) and a random acceleration (related in fact with Stokes's frictional coefficient in a definite manner). There is, however, one important difference: in the stellar case stars influence each other, while in Brownian motion the colloidal particles are influenced only by the molecules of the surrounding fluid. But physically, the close analogy that exists between the motion of a star in the fluctuating gravitational field of its neighbors and the motion of a colloidal particle describing Brownian motion results from the following circumstance: Even as the collision with a single molecule of the surrounding liquid hardly affects the motion of a colloidal particle, so also does an elementary fluctuation in the force due to the neighbors hardly affect

[2] For a comprehensive account of these attempts see H. N. Russell, SCIENCE, 92: 19, 1940.

[3] The interested reader may refer to S. Chandrasekhar, *Astrophysical Journal*, 97: 255–262, 1943.

[4] It can further be shown that the ratio of the diffusion coefficient to the frictional coefficient is a constant of the system.

the motion of a star; and in both cases what is of importance is the cumulative effect of a large number of separate events, each having only a very minute effect.

Having described the manner in which the motion of a star is influenced by a fluctuating force acting on it, it is evident that we should, in principle, be able to calculate the probability with which a star initially having a given velocity will acquire (for the *first time*) some other preassigned velocity at some specified later time. And if a star should acquire in this manner a velocity sufficient to escape from the entire gravitational attraction of the cluster altogether, then we should have calculated the probability that the star would escape from the cluster at the specified later time. In other words, we have here a rational means for estimating the rate at which stars may be expected to escape from a cluster and thus an estimate of the rate at which clusters tend to disintegrate. On carrying through the necessary calculations[5] it is found that we can express the probability that a star would have escaped from the cluster during a time t in the form

$$1 - e^{-t/t_0} \qquad (1)$$

where t_0 is a certain time related in a definite way to the physical parameters of the cluster (*e.g.*, its radius, star density, etc.). According to the foregoing formula, in a time equal to t_0 the probability that a star would have escaped from the cluster amounts to as much as 0.63. Accordingly, t_0 may be taken as a measure of the average life of the cluster. For the Pleiades it is found that t_0 is about 3×10^9 years. Since, however, the Pleiades are in no way exceptional as a galactic cluster it may be concluded that galactic clusters in general have mean lives of this order. On the other hand, galactic clusters appear to be an essential feature of the Milky Way system. It would, therefore, appear that the existence of galactic clusters like the Pleiades would point to a time scale for the galaxy of the order of 3×10^9 years. This is the first of the two major galactic evidences to which we referred at the outset. We now turn our attention to the second evidence.

As is well known, a very substantial fraction of all the stars occur as components of multiple stars. And by far the most important among these multiple stars are the binaries. We shall now indicate how from a study of the statistics of binary stars,[6] *i.e.*, from a study of the frequencies of occurrence of the various parameters of the binary such as its period, eccentricity, the semi-major axis of the relative orbit, etc., we can draw some conclusions bearing on the question of the time scale. As in the case of galactic clusters the basis for the discussion is again provided by considerations relating to stability. However, while the "instability" of the clusters arose from the possibility of its members accidentally acquiring under the influence of the other cluster members velocities sufficient to escape from the cluster, in the case of binaries the tendency towards disruption is caused by the tidal effects of the nearby stars. For, the distances of the neighboring stars from the two components of the binary, respectively, will be different; consequently, the net forces acting on the two components will also differ. For the separations between the components normally encountered, and which are of practical interest, this difference in the forces acting on the two components will in general be only very slight. But it is precisely this difference operating over sufficient lengths of time that will cause the eventual dissolution of a binary. Without going into the details of the calculation[7] it may be stated that under the conditions prevailing in the general neighborhood of the sun in the Milky Way, the time of dissolution of a binary can be expressed as

$$\tau = 2.2 \times 10^{15}\, a^{3/2} \text{ years} \qquad (2)$$

where a denotes the semi-major axis of the relative orbit in astronomical units ($= 1.5 \times 10^8$ km). The meaning of the foregoing formula is simply that in a time τ the tidal effect of the neighboring stars is sufficient to accelerate one component of the binary relative to the other by an amount which will make the kinetic energy of relative motion of the two components exceed the gravitational binding energy between them. And now, according to formula (2), binaries with separations between 1,000 and 10,000 astronomical units will be "dissociated" in times ranging from 7×10^{10} to 2×10^9 years. This result can be reinterpreted as follows: Suppose we consider an interval of time of 10^{10} years. Then during such an interval the dynamical elements of binary orbits with semi-major axes between 1,000 and 10,000 astronomical units will have suffered substantial changes. In other words, for these binaries the distribution over the different parameters must (in course of 10^{10} years) tend towards what should be expected under conditions of statistical equilibrium. But it has been shown by V. A. Ambarzumian[8] that the observed distribution of the separations among the binaries, in the range 1000–10,000 astronomical units, is such that those with the larger separations occur with far less frequency than should be expected under conditions approximating those of equilibrium. Accordingly, we should

[5] For the details see S. Chandrasekhar, *Astrophysical Journal*, 98: 54–60, 1943.

[6] The most recent of such statistical studies is that due to G. P. Kuiper, *Astrophysical Journal*, 95: 201, 1942.

[7] For these see a forthcoming paper in the *Astrophysical Journal*.

[8] *Russian Astronomical Journal*, 14: 207, 1937; also *Nature*, 137: 537, 1936.

conclude that sufficient time has not elapsed for the tidal forces of the neighboring stars to appreciably modify the elements of binary orbits with separations in the range stated. This implies that 10^{10} years represents a true upper limit to the time scale, and would suggest a time scale of the order of, say, 5×10^9 years.

The discussion of the mean lives of galactic clusters and the statistics of binary stars agree therefore in pointing to a time scale of the order of a few billion years. We may now briefly summarize the other evidences which also point to a similar time scale. First, we have the geochemical evidence derived principally from the lead content of minerals containing uranium salts and leading to the ages of the igneous rocks containing these minerals. In our present context most interest is naturally attached to those determinations which lead to the greatest ages. Thus, the analysis of a pegmatite in Manitoba containing uranite, monozite and mica leads to three independent determinations of age ranging from 1,600 to 1,900 millions of years. We may say then that a billion and a half years represents a true lower limit to the age of the earth. An upper limit can also be found (as was first indicated by H. N. Russell) from the entire lead content of the earth's crust on the assumption that all of it has been derived as the end products of radioactive disintegrations. In this manner an upper limit of three and a half billion years has been estimated. In other words, the age of the earth has been bracketed between one and a half and three and a half billions of years. Similar ages have also been found for the meteorites from their helium content.

Still another evidence for the time scale comes from the velocity interpretation of the "red shift" shown by the extra-galactic nebulae and the velocity-distance relationship of Hubble. As is well known, this relationship can be interpreted as meaning that some two billion years ago all the nebulae were confined to a relatively very small volume and that they were projected with their present speeds in their present directions. It is, of course, possible that the velocities of the nebulae were different at earlier epochs, but the interpretation given is probably adequate for drawing inferences concerning the time scale.

Finally, we may also draw attention to the information that can be derived from clusters of extragalactic nebulae such as the Coma and the Virgo clusters. The Virgo cluster, for example, includes some 400 nebulae in a spherical volume of about 200,000 parsecs radius. It is not certain that the Newtonian laws of gravitation can be applied to objects of this size. But we can probably apply the theory which we have described for the galactic star clusters to the clusters of nebulae to obtain very rough estimates. In this manner Miss Tuberg[9] has recently estimated for the Virgo cluster a mean life of the order of 10^{11} years.

To conclude, then, we see that the geochemical evidence bearing on the age of the earth and meteorites, the galactic star clusters, the statistics of binary stars, the clusters of extragalactic nebulae and finally the system of the nebulae, all agree in pointing to a time scale of the order of a few billion years. It does not seem that this can be accidental.

SOVIET STUDIES ON VIRUSES[1]

By Dr. W. M. STANLEY

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ON February 12 in 1892 a young man, Dmitrii Iwanowski, appeared before the Academy of Science at St. Petersburg and presented his second scientific contribution, a short four-page paper entitled "On the Mosaic Disease of the Tobacco Plant."[2] Most of this short paper was devoted to an innocuous discussion of the symptomatology of the disease as he had observed it in the Crimea, and it is only near the end that there was given a one-sentence description of an experiment which has come to be recognized as a landmark in medical history. This sentence goes as follows:

"Yet I have found that the sap of leaves attacked by the mosaic disease retains its infectious qualities even after filtration through Chamberland filter-candles." This filtration experiment by Iwanowski led to the discovery of viruses, which we now recognize as a large group of infectious agents, smaller than ordinary living organisms, that may cause disease in man, animals, plants and bacteria. To this group belong the agents responsible for such diseases as smallpox, yellow fever, poliomyelitis, influenza, the virus pneumonias of man, horse encephalomyelitis, foot-and-mouth disease of cattle, hog cholera, rabies, dog distemper, fowl pox, certain types of tumorous growths in fowls and other animals, jaundice of silk-worms, various yellows and mosaic diseases of plants and

[1] Address at the Science Panel of the Congress of American-Soviet Friendship, New York, November 7, 1943. The complete proceedings of the Science Congress including the Medical Session will be published at a later date by the National Council of American-Soviet Friendship.

[2] D. Iwanowski, *Bull. Acad. Imp. Sci. St. Petersburg*, 3: 67, 1892.

[9] *Astrophysical Journal*, 98: 501, 1943.

the transmissible lysis of bacteria. Although vaccination as a means of protection against smallpox was in use long before the recognition of the existence of viruses and notable success in the prevention of yellow fever and encephalomyelitis has been achieved recently by vaccination with mild virus strains or with inactivated virus, there remain many important diseases, such as the virus pneumonias, influenza, poliomyelitis and several afflictions of animals and plants, for which there now exists no acceptable means of protection of whole populations. The newer wonder materials, such as the sulfa drugs and penicillin, generally have not been found to be effective in the treatment of virus diseases. From a medical standpoint, therefore, the viruses have come to represent a most important group of infectious disease-producing agents.

Iwanowski was certainly unaware of the great importance and significance of the filtration experiment which he described in 1892. He regarded the mosaic disease as bacterial in nature and suggested that his unusual results might be due to a defect in the filter candle or to the presence of a bacterial toxin. However, six years later Beijerinck confirmed Iwanowski's filtration results and proved by serial passage of the filtrate that the infectivity was due to a filterable agent and not to a bacterial toxin.[3] Beijerinck referred to the active agent as a "contagious living fluid" and appeared to believe that it was not bacterial in nature but was an unorganized entity. The same year, Loeffler and Frosch reported that the foot-and-mouth disease of cattle was due to a virus,[4] and in 1901 yellow fever was found by Reed and co-workers to be a virus disease of man.[5] It is not surprising that Iwanowski failed to grasp immediately the full significance of his 1892 filtration experiments, for the results were directly contrary to all accepted scientific knowledge. However, when similar results were obtained with diseases of man and animals, he seemed to have recognized the challenge which was presented and immediately set about to learn something of the nature of tobacco mosaic virus. He reported his extensive experiments on this virus in a 40-page paper published in 1903.[6] The nature of the experiments which he conducted and the manner in which they were carried out and discussed serve to mark Iwanowski as a most able investigator. He was aware that tobacco mosaic virus represented the first of a new kind of infectious disease-producing agent, and he recognized fully the great difficulty in describing exactly the nature of an agent that could pass a Chamberland filter but not a dialysis membrane and one which could reproduce only within living cells and not on artificial media. The ideas that he expressed are quite similar to those held to-day by many leading virus workers. Iwanowski's 1903 paper is also notable for his accurate description of the intracellular inclusions in the cells of mosaic-diseased plants. His description of the needle crystals formed within diseased cells upon the addition of acid is of interest, for in the light of present-day knowledge it seems likely that this material was crystalline tobacco mosaic virus. Iwanowski's claim to fame has grown with the years and, although his life has not been treated biographically and even the place of his birth and early training appear to be unrecorded in the scientific literature, I believe that his relationship to viruses should be viewed in much the same light as we view Pasteur's and Koch's relationship to bacteriology. There is considerable justification for regarding Iwanowski as the father of the new science of virology, a field of endeavor which to-day is of great importance not only in medicine but in several closely allied fields of study.

For over thirty years, studies on viruses were at a low ebb in Russia as well as in other countries. Most of the work consisted of the description of new virus diseases, of the pathology involved therein and of the ways by means of which viruses are transmitted from host to host. However, the coming importance of plant viruses was recognized by Rischkov, then professor of plant pathology at Charkow, who in 1935 published a book entitled "Virus Diseases of Plants."[7] The isolation in this country in 1935 of tobacco mosaic virus in the form of a crystalline nucleoprotein of high molecular weight[8] was immediately recognized in Russia as providing a new approach to the study of viruses. This finding was soon repeated and confirmed by Rischkov at the Microbiological Institute in Moscow.[9] In 1937 and again in 1938 Rischkov published reviews in the Russian language of the extensive work which had been carried out in this country and in England on purified virus preparations.[10,11] In 1938 he published with Gromyko a description of a new method for the purification of tobacco mosaic virus.[12] Rischkov also demonstrated with Soukhov the important fact that crystalline tobacco mosaic virus possesses no enzymatic activity other than that of virus activity.[13] Goldin, working at the Microbiological

[3] M. W. Beijerinck, *Verh. Akad. Wetensch., Amsterdam, II, no. 5*, 6: 1, 1898.
[4] F. Loeffler and P. Frosch, *Zentralbl. Bakt., I, Orig.*, 28: 371, 1898.
[5] W. Reed, J. Carroll, A. Agramonte and J. Lazear, see *Senate Documents*, 66(822): 156, 1911.
[6] D. Iwanowski, *Zeitschr. Pflanzenkr.*, 13: 1, 1903.
[7] V. L. Rischkov, "Virus Diseases of Plants," Moscow, 1935.
[8] W. M. Stanley, SCIENCE, 81: 644, 1935.
[9] V. L. Rischkov, Private communication.
[10] *Idem, Microbiologiia*, 6(6): 830, 1937.
[11] *Idem, Progress of Contemporary Biology U.S.S.R.*, 9: 351, 1938.
[12] V. L. Rischkov and E. P. Gromyko, *Compt. rend. acad. sci. U.R.S.S.*, 19: 203, 1938.

Institute in Moscow, reported that putrefactive bacteria do not decompose crystalline tobacco mosaic virus and that virus may be adsorbed by various microorganisms.[14] Goldin also published a paper on "Some Data Concerning Crystalline Inclusions in the Mosaic Virus Disease of Tobacco," in which he called attention to the similarity between the properties of crystalline tobacco mosaic virus and those of the crystalline material described by Iwanowski in 1903.[15] The effect of ether on bacteriophages and tobacco mosaic virus was studied by Goldin, who found neither agent to be soluble in ether.[16]

In addition to the work that I have described, Russian investigators have made studies of a practical nature on several virus diseases, chiefly of virus diseases of cereal crops. Studies of importance have also been made on virus diseases of man and animals. For example, in 1937 Smorodintseff and coworkers reported the results of a study in which volunteers were inoculated experimentally with influenza virus[17] and in 1940 an investigation was described in which biweekly inhalations of vaporized influenza antiserum were given to a large number of persons before and during an influenza epidemic.[18] These two methods of approach to the influenza problem have subsequently been employed by American workers. It should perhaps be noted that the inhalation of antiserum has yielded the most favorable results yet reported in connection with the prevention of influenza in man. The war does not appear to have interfered seriously with virus studies in Russia, for in a paper in last month's *Phytopathology* entitled "The Nature of Ultra-Viruses and Their Biological Activity," Rischkov[19] mentions a conference on plant virus diseases which was held in Moscow in 1941 and describes researches which were reported at a meeting of the Ukrainian Academy of Sciences in January, 1942. In 1942 a number of the Russian journal *Microbiology*[20] was issued in celebration of the fiftieth anniversary of Iwanowski's filtration experiment with tobacco mosaic virus. In the introductory article Koshtoiants[21] not only describes and evaluates Iwanowski's early findings but also much of the contemporary work on viruses. The author's defense of the importance of Russian science and the occasional indulgence in polemics appear unnecessary. The important researches of Engelhardt and Ljubimowa on the enzyme activity of myosin, of Rischkov on plant viruses, of Graschenkoff on encephalitis, of Petroff on tumors, of Gamali on immunity and of Smorodintseff on influenza are mentioned with justifiable pride. In the second paper Rischkov[22] discusses the origin of viruses and in two succeeding articles Suchov[23] and Vovk[24] describe some recent work on plant viruses.

Let us all hope that it will not be long before the rich promises of Iwanowski's early work on viruses will be even more fully realized in Soviet Russia.

OBITUARY

RECENT DEATHS

ARTHUR KEITH, from 1894 until his retirement in 1934 geologist of the U. S. Geological Survey, died on February 7 at the age of eighty-one years.

DR. BERNARD SACHS, formerly professor of clinical neurology at the College of Physicians and Surgeons of Columbia University and director of the division of child neurology at the Neurological Institute, died on February 8 at the age of eighty-six years.

DR. ARTHUR RENWICK MIDDLETON, since 1939 emeritus professor of inorganic chemistry at Purdue University, a member of the faculty for forty years, died on February 6 in his seventy-fifth year.

DR. DAVID ELDRIDGE WORRALL, professor of organic chemistry and director of the chemical laboratory at Tufts College, died on February 7. He was fifty-seven years old.

SCIENTIFIC EVENTS

THE POLISH FACULTY OF MEDICINE AT EDINBURGH UNIVERSITY

A CORRESPONDENT of the *Journal* of the American Medical Association writes: "The only existing scientific institution with university standing which a great European nation has maintained is the Polish School of Medicine in the University of Edinburgh. It is unique in the fact that never before has any state set

[13] V. L. Rischkov and K. S. Soukhov, *Compt. rend. acad. sci. U.R.S.S.*, 21: 265, 1938.
[14] M. I. Goldin, *Compt. rend. acad. sci. U.R.S.S.*, 20: 735, 1938.
[15] *Idem*, *Microbiology U.S.S.R.*, 7: 353, 1938.
[16] *Idem*, *Bull. Acad. Sci. U.R.S.S.*, 173, 1938.
[17] A. A. Smorodintseff, M. D. Tushinsky, A. L. Drobyshevskaya, A. A. Korovin and A. I. Osetroff, *Am. Jour. Med. Sci.*, 194: 159, 1937.
[18] A. A. Smorodintseff, A. G. Gulamow and O. M. Tschalkina, *Zeitschr. klin. Med.*, 138: 756, 1940.
[19] V. L. Rischkov, *Phytopathology*, 33: 950, 1943.
[20] The writer is especially indebted to Dr. S. A. Waksman of Rutgers University for providing this number of *Microbiology* (Vol. 11, No. 4, 1942) and to Dr. M. Kunitz of the Rockefeller Institute for assistance in reading two of the articles.
[21] C. S. Koshtoiants, *Microbiology U.S.S.R.*, 11: 139, 1942.
[22] V. L. Rischkov, *Microbiology U.S.S.R.*, 11: 149, 1942.
[23] K. S. Suchov, *Microbiology U.S.S.R.*, 11: 168, 1942.
[24] A. M. Vovk, *Microbiology U.S.S.R.*, 11: 177, 1942.

up its own university with its own professors lecturing to its own students in their native tongue on foreign soil as part of a foreign university. After the collapse of France in June, 1940, many Polish medical officers escaped and collected in one of the Polish army camps in Scotland. Among them were several professors, lecturers and specialists of high standing whose knowledge and experience could not be used in the early stages of the reorganization of the Polish army on British soil. Lieutenant Colonel F. A. E. Crew, commanding the Scottish Military Hospital, was one of the first to realize the needs of Poland, and in October, 1940, initiated the scheme which led to the creation of the Polish Faculty of Medicine within the University of Edinburgh.

"Profesor Antoni Jurasz, dean of the Polish Medical School, has stated in a press interview that the Poles in Britain were eager to welcome any scheme which would ensure close collaboration of the universities and scientific worlds of the two countries after the war. There has been an increasing response from the Poles in Great Britain to the establishment of the medical school. The total for the current year was 200 students, and the total number of doctors graduated from the Polish Medical School is fifty-three. The training of undergraduates and newly qualified doctors is carried on in the Paderewski Hospital, which is devoted entirely to the care of Poles in Britain. This hospital was established mainly through the foresight of an American, Mrs. Charlotte Hoffman Kellogg, president of the Paderewski Testimonial Fund, which has provided equipment and individual help to needy students from the Middle East. The physicians at the hospital are all Polish, the heads of the departments being professors or lecturers at the university. There are at present 116 beds, of which two thirds are for medical and the remainder for surgical cases."

THE REFRIGERATION RESEARCH FOUNDATION

THE Refrigeration Research Foundation, a non-profit-making corporation, was organized under Illinois laws on October 14, 1943. It is composed of two groups—public members who have achieved civic distinction, and sustaining members, representatives of companies who have contributed funds to the program of the foundation. It will begin its work with an initial fund of $250,000, which will be expended in grants for research to be carried on in the laboratories of already established colleges, universities and technological institutions. The funds will be provided by subscriptions from corporations, firms or individuals engaged in the preservation of food or other commodities by refrigeration. Research will be carried on in Canada and Mexico as well as in the United States. Its objects are:

To improve the methods of refrigeration for the better preservation of food and other commodities essential to the health and welfare of the American people.

To develop and support research in the science and art of refrigeration of food and other commodities through a nationwide program of financial grants to established institutions and agencies of research.

To establish fellowships in institutions and agencies of research and thereby to aid in the training of competent personnel to give activation and leadership to the refrigeration of commodities essential to the national economy.

To establish in the interest of the American people a repository of scientific information relating to the refrigeration of food and other materials.

To cooperate with and aid agencies of Federal and State governments, institutions of research and others in connection with their scientific and educational work involving the refrigeration of food and other products.

The foundation will not engage in any business or activity customarily performed for profit nor will it engage in any political activity or carry on propaganda or attempt to influence legislation.

The president of the foundation is Roy M. Hagen, of Los Angeles; the director of the scientific program is H. C. Diehl, principal chemist and chief of the commodity processing division of the Western Regional Research Laboratory of the U. S. Department of Agriculture. Dr. Samuel C. Prescott, who until 1942 was dean of science at the Massachusetts Institute of Technology, now emeritus professor of biology, was elected chairman of the Board of Governors to serve until the first annual meeting. At that meeting he was appointed director of the institute. His headquarters will be at Berkeley, Calif.

THE INSTITUTE OF AVIATION PSYCHOLOGY

A RESEARCH institute on "aviation psychology" is being established at the University of Tennessee through the cooperation of both state and national organizations. The Civil Aeronautics Administration and the Tennessee State Bureau of Aeronautics are providing funds for the institute. A committee of the National Research Council in cooperation with the special project committee of the University of Tennessee will direct research. Colonel Herbert Fox, of the Tennessee Bureau of Aeronautics, has been active in establishing the institute.

Special attention will be given to problems of training and to developing methods of instruction and training aids which can help to reduce failures among student pilots and to decrease the incidence of accidents following the completion of training. Research work has already been carried out by the Government

at various universities, with funds made available by the Civil Aeronautics Administration, under the general supervision of an executive subcommittee of the National Research Council Committee on Selection and Training of Aircraft Pilots consisting of Dr. Charles W. Bray, Dr. Dean R. Brimhall, Commander Daniel J. Brimm, Dr. Leonard A. Carmichael, Lieutenant Commander Jack W. Dunlap, Lieutenant Colonel John C. Flanagan, Professor Harry M. Johnson, Dr. Walter R. Miles, Dr. G. R. Wendt and Professor Morris S. Viteles, *chairman*.

Research projects, in consultation with the Division of Research of the Civil Aeronautics Administration, will be planned jointly by Dr. Robert Y. Walker, formerly of the Ohio State University, director of the institute; the project committee of the University of Tennessee, including Professors E. S. Fabian, K. L. Hertel, P. B. Stockdale and Dr. E. A. Waters, and the executive subcommittee of the Committee on Selection and Training of Aircraft Pilots. The staff of the institute will include Dr. R. E. Dunford and S. E. Torsten Lund, of the University of Tennessee, as well as others drawn from current projects of the Committee on Selection and Training of Aircraft Pilots. It is anticipated, however, that work will continue on a number of projects centered at other universities.

Headquarters will be at the university, but special facilities for research will be provided at the University Airport, formerly known as "Island Airport" in Knoxville.

Establishment of the institute represents the fulfilment of plans formulated by Dr. Dean R. Brimhall, director of research of the Civil Aeronautics Administration, in consultation with the committee of the National Research Council. The committee believes that "the establishment of an institute of aviation psychology at a state university, supported by state as well as by federal funds, represents a method of assuring the continuation of such research in the postwar era with a renewed emphasis upon the problems of civilian flying. Through such an institute and others like it at other universities, steps can be taken to avoid the unfortunate cessation of basic and practical research which occurred at the close of the last war."

THE LECTURESHIP ON METALLURGY AT THE UNIVERSITY OF SAO PAULO

DR. ROBERT F. MEHL, professor and head of the department of metallurgical engineering and director of the Metals Research Laboratory of the Carnegie Institute of Technology, Pittsburgh, left on February 13 for Brazil to deliver the second of a series of lectures on metallurgy established last summer at the Escola Politecnica of the University of São Paulo. The project is jointly financed through the office of Nelson A. Rockefeller, coordinator of Inter-American Affairs, and the university and is administered by the Stevens Institute of Technology.

Professor Mehl is the second of four United States authorities in the field of metallurgy to deliver lectures on this subject over a period of a year, each spending three months in São Paulo. The first lecturer was Dr. A. Allan Bates, manager of the metallurgical department of the Research Laboratories of the Westinghouse Electric and Manufacturing Company, East Pittsburgh. The third lecturer in the series will be Professor Arthur Phillips, of the Hammond Metallurgical Laboratory at Yale University, and the fourth Professor Gregory Jamieson Comstock, director of the Powder Metallurgy Laboratory at Stevens Institute.

Professor Bates's lectures covered industrial research and development in metallurgy. Dr. Mehl will lecture, beginning on March 1, on the physical metallurgy of iron and steel. Laboratory facilities for metallurgical work are available in São Paulo at the Instituto de Pesquisas Tecnologicas, which is connected with the Escola Politecnica. Modern research and production equipment is provided.

In addition to the formal lectures, which are given in English, oral conferences, attended by representatives from industry, have been arranged. These are conducted by means of questions and answers, with interpreters in attendance. Manufacturing practices employed in the United States and specific details from the viewpoint of Brazilian practices are the subjects of discussion.

CONFERENCE OF THE INSTITUTE OF FOOD TECHNOLOGISTS

THE fifth annual meeting of the Institute of Food Technologists will be held in Chicago at the Edgewater Beach Hotel on May 29, 30 and 31. The program will include addresses and the presentation of technical papers by authoritative speakers. An attendance is expected of more than seven hundred chemists, physicists, biologists, engineers and production executives engaged in food manufacturing and processing.

The presentation of the Nicholas Appert Medal Award for 1944 of the Chicago Section will be made on May 30 to Dr. Charles Albert Browne, of the U. S. Department of Agriculture, in recognition of "outstanding contributions to food technology." The ceremony will be preceded by a banquet at the hotel.

The medal was presented for the first time in 1942 when the award went to Dr. W. V. Cruess, professor of fruit products at the University of California.

Dr. S. C. Prescott, dean emeritus of science of the Massachusetts Institute of Technology at Cambridge and first president of the institute, was the recipient of the second award last year.

Announcement of the selection of Dr. Browne to receive the 1944 medal was made on February 15. The medalist is elected by a jury of nine distinguished technologists representing various divisions of the food processing industry and from as many different geographical areas. Eligibility for the award is based on preeminence in the field of food technology and on contributions to the progressive development of food manufacture and processing.

Dr. Browne's contributions to food technology began in his undergraduate years at Williams College when he began the study of carbohydrates. He received his doctorate at the University of Göttingen. Later he was successively chief of the Sugar Laboratory of the U. S. Bureau of Chemistry, chief chemist of the New York Sugar Trade Laboratory, chief of the Bureau of Chemistry and chief of chemical and technological research of the Bureau of Chemistry and Soils. The citation reads in part: "He has been an unfettered investigator who struggled to remain free of administrative burdens, finally culminating in his appointment as supervisor of chemical research. He is justly deserving of the honor of the Nicholas Appert Medal if only for his researches and contributions to sugar technology, constituting as they do to-day an imposing and vital section of the literature and technology of carbohydrates." Presentation of the award will be made to Dr. Browne by Dr. M. L. Laing, chairman of the Chicago Section.

A feature of the meeting again this year will be an industrial exhibit in the hotel. Space will be assigned for thirty exhibits, which will be free to the public.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT the meeting of the Executive Committee of the American Association for the Advancement of Science on February 6, the following actions were taken:

Section committeemen for a four-year term ending December 31, 1947:

Mathematics, T. R. Hollcroft, Wells College.

Physics, Joseph C. Boyce, Massachusetts Institute of Technology, Cambridge, Mass.

Astronomy, Bart Jan Bok, 32 Scott Road, Belmont, Mass.

Geology and Geography, Carey Croneis, University of Chicago.

Zoological Sciences, Charles W. Metz, University of Pennsylvania.

Botanical Sciences, J. W. Shive, New Jersey Agricultural Experiment Station.

Anthropology, Ralph Beals, University of California at Los Angeles.

Psychology, Willard L. Valentine, 620 University Place, Evanston, Ill.

Social and Economic Sciences, Frederick C. Mills, Columbia University.

Historical and Philological Sciences, Arno B. Luckhardt, University of Chicago.

Medical Sciences, N. C. Foot, 340 East 72nd Street, New York, N. Y.

Agriculture, C. E. Kellogg, U. S. Agricultural Research Administration.

Education, S. R. Powers, Teachers College, Columbia University.

It was voted to hold the annual meeting of the association for 1944 in Cleveland, Ohio, during the week of September 11–16.

It was voted to bring to the attention of the association and of all the affiliated societies that in all programs of the September meeting emphasis be placed on the indispensability of science for the future of civilization, both in war and in peace.

Publication of the conference on hormones, presented at the Gibson Island Research Conferences in Chemistry in 1943, was authorized.

The Population Association of America and the Electron Microscope Society were accepted as associated societies of the association.

The election of Dr. Burton E. Livingston as chairman and of Dr. Roger Adams as a member of the committee and the election of vice-presidents of the sections were reported last week (SCIENCE, February 11, pp. 120–121).

SCIENTIFIC NOTES AND NEWS

DR. IRVING LANGMUIR, associate director of the General Electric Research Laboratory, has been awarded the Faraday Medal of the Institution of Electrical Engineers, London. The medal was established in 1922 and is given for world-wide services to electric science and engineering. Among those who have received the award are Oliver Heaviside, Sir J. J. Thomson, Lord Rutherford and Sir Oliver Lodge. Dr. Langmuir is the fourth American to receive this medal. In 1927 it was given to Professor Elihu Thomson, one of the founders of the General Electric Company; in 1935 to Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, and in 1939 to Dr. William D. Coolidge, vice-president in charge of research of the General Electric Company.

THE Medal of Honor of the American Institute of Radio Engineers was presented at the annual dinner on January 28 to Haraden Pratt, chief engineer of the Mackay Radio and Telegraph Company, "in recog-

nition of engineering contributions to the development of radio." The Morris Liebmann Memorial Prize for 1943 was presented to W. L. Barrow, professor of electrical engineering at the Massachusetts Institute of Technology, "for theoretical and experimental work done in ultra-high frequency propagation." Speakers at the dinner included Dr. Lynde P. Wheeler, the retiring president of the institute, and Professor H. M. Turner, of Yale University, the newly elected president.

THE Faculty of Medicine of the University of Toronto has awarded the Charles Mickle Fellowship for 1943 to Dr. Evarts A. Graham, Bixby professor of surgery at the School of Medicine of Washington University, St. Louis, surgeon-in-chief of the Barnes Hospital, in recognition of "his discovery of a method of testing gallbladder functions by the use of certain organic compounds and the diagnosis and treatment of carcinoma of the lung."

THE William Herbert Medal, awarded annually by the American Amaryllis Society for outstanding achievement in the field of the Amaryllidaceae, has been presented to Dr. Henry A. Jones, principal olericulturist at the station at Beltsville, Md., of the U. S. Bureau of Plant Industry, in recognition of his "important contributions to the cytology, genetics, breeding and culture of the onion, *Allium Cepa*."

A PORTRAIT of Dr. Frederic A. Woll, chairman of the department of hygiene at the College of the City of New York, presented to the college by the department, was unveiled on January 29.

DR. HELEN M. WALKER, professor of education at Teachers College, Columbia University, has been elected president for 1944 of the American Statistical Association. She succeeds E. A. Goldenweiser, director of the Federal Reserve Bank, Washington, the retiring president.

IT is reported in *The British Medical Journal* that the Medical Research Council of Ireland has awarded full-time fellowships to Dr. V. C. Barry, for investigations on the chemotherapy of tuberculosis; to Dr. Michael Flynn, on the typhoid-carrier condition; to Dr. P. A. McNally, on the chemotherapy of tuberculosis, and to Dr. Dermot Murphy, on the production of penicillin.

DR. JOHN M. FOGG, JR., associate professor of botany and dean of the College of Arts and Sciences, has been elected vice-provost of the University of Pennsylvania.

AT the University of Florida, Dean H. Harold Hume has been appointed provost for agriculture and dean of the College of Agriculture to succeed the late Dr. Wilmon Newell; Harold Mowry, associate director, has been promoted to be director of the Agricultural Experiment Station, and A. P. Spencer to be director of the Agricultural Extension Service.

DR. ARILD E. HANSEN, professor of pediatrics at the Medical School of the University of Minnesota, has become professor of pediatrics and chairman of the department of pediatrics in the School of Medicine at Galveston of the University of Texas and director of the Child Health Program at the university of the William Buchanan Foundation of Texarkana. The Child Health Program plans the further development and expansion of the department of pediatrics, to include research and to create opportunities for practicing physicians to participate more effectively in promoting child health.

DR. C. V. NEWSON, of the University of New Mexico, has been appointed professor of mathematics and head of the department of Oberlin College. He will take up his new work on July 1.

DR. W. W. WORZELLA, associate in agronomy at Purdue University, has been made head of the department of agronomy of South Dakota State College.

DR. ELIZABETH KRAUSKOPF BUSHNELL, adjunct professor of bacteriology at the University of South Carolina, has been appointed, effective on February 1, assistant professor of bacteriology at the University of Hawaii.

DR. GEORGE B. DARLING has resigned as president and comptroller of the W. K. Kellogg Foundation in Battle Creek to accept appointment as executive secretary of the Committees on Military Medicine of the Division of Medical Sciences of the National Research Council, Washington, D. C.

MAURICE HOLLAND, for twenty years director of the engineering and industrial research division of the National Research Council, has been appointed industrial research adviser to the Armour Research Foundation of Chicago.

DEAN SAMUEL T. DANA, of the School of Forestry and Conservation of the University of Michigan, editor of the *Journal of Forestry*, has become a member of a subcommittee of the Michigan State Planning Commission, formed to recommend the development of industrial and natural resources in the Upper Peninsula; he has also been made a member of the advisory council to aid in a survey of the effects of the war on the forest resources of the United States.

CHARLES H. BRIGGS has joined the staff of the Truesdail Laboratories of Los Angeles. For forty-two years he has been manager of the Howard Wheat and Flour Testing Laboratory of Minneapolis, where he took part in introducing and perfecting some of

the chemical and physical tests applied to cereals and their products, including the protein test of wheats.

DR. LOWELL T. COGGESHALL, professor of epidemiology at the School of Public Health of the University of Michigan, has leave of absence to enable him to become medical director for the Marine Rehabilitation Program on the west coast.

DR. ROGER C. SMITH, head of the department of entomology of the Kansas State College, has been granted leave of absence to become professional allocations specialist of the War Manpower Commission for the Agricultural and Biological Sciences. He took up this work in Washington, D. C., on February 1.

DR. KIRTLEY F. MATHER, professor of geology at Harvard University, editor of the Scientific Book Club, lectured on February 17 before the Lancaster Branch of the American Association for the Advancement of Science. He spoke on "Natural Resources and World Organization."

THE address of Dr. Leland W. Parr, of the School of Medicine of the George Washington University, delivered on February 17 as retiring president of the Washington Academy of Sciences, was entitled "Aspects of the Epidemiology of Tuberculosis."

AT the meeting on January 21 of the Johns Hopkins Medical History Club, Dr. G. L. Streeter spoke on "The Origin of the Three Germ-Layer Theory and Its Present Significance," and Dr. Erwin H. Ackerknecht spoke on "White Indians."

DR. B. H. WILLIER, professor of biology at the Johns Hopkins University, addressed the Alpha Mu Chapter of Beta Beta Beta at Western Maryland College on January 31. His address was entitled "The Development of Color Patterns in the Feathers of Chickens."

DAVID DIETZ, science editor of the Scripps-Howard Newspapers, addressed the scientific staff of the Goodyear Research Laboratory in Akron, Ohio, on January 31. He spoke on "Science and the Future."

DR. K. C. D. HICKMAN, vice-president and director of research of the Distillation Products, Inc., Rochester, N. Y., will deliver Sigma Xi lectures on the general subject of vitamins during February and March at Swarthmore College, the University of Virginia, the Virginia Polytechnic Institute, the University of North Carolina, the University of Florida, Emory University, the Louisiana State University, the University of Illinois, Indiana University, Michigan State College, Western Reserve University and the University of Missouri.

THE Council of the American Association of Pathologists and Bacteriologists has voted that a scientific meeting of the association will not be held in the year 1944.

THE thirty-fifth annual meeting of the American Oil Chemists Society will be held in New Orleans, on May 10, 11 and 12. The Roosevelt Hotel has again been selected as headquarters for the convention and all technical sessions, committee meetings and the annual dinner will be held there. The local committee, of which Dr. George W. Irving, Jr., of the Southern Regional Research Laboratory at New Orleans, is chairman, is arranging a program of papers which will include the chemical, analytical, technological, industrial and economic phases of fats and oils. Interested guests may register. Hotel reservations should be made as soon as possible through Roy R. Bartlett, convention manager of the hotel.

THE dedication of the M. D. Anderson Hospital for Cancer Research at Houston, Texas, under the auspices of the M. D. Anderson Foundation of the University of Texas, of which Dr. E. W. Bertner is acting director, took place on February 17. The guest speakers included The Honorable Coke Stevenson, Governor of Texas; Dr. Homer P. Rainey, president of the University of Texas; Dr. Charles S. Venable, president of the State Medical Association; Dr. Bowman C. Crowell, associate director of the American College of Surgeons; Dr. Frank E. Adair, chief surgeon of the Memorial Hospital, New York, and Dr. Clarence C. Little, managing director of the American Society for the Control of Cancer. The address of welcome was made by the Honorable Otis Massey, mayor of the City of Houston.

THE fortieth anniversary of the first flight of the Wright brothers and the thirty-fifth anniversary of Russian aviation were recently celebrated by a meeting of the Scientific Council of the Ordzhonikidze Aviation Institute in Moscow.

THE British Minister, John Balfour, on January 6 presented to the Soviet Academy of Science a first edition of Isaac Newton's "Principia," a gift from the Royal Society. This book contains the original of a letter writter by Newton to Alexander Menshikoff.

THE *Journal* of the American Medical Association reports that funds estimated at more than eight million dollars have been left in trust by the late Mrs. Elizabeth Severance Prentiss for the advancement of medicine, health, art, music, education and religion. Thirty-seven per cent. of the assets are set aside to support the Elizabeth Severance Prentiss Foundation. The institutions that will receive trust assets reserved for the public welfare include Western Reserve University, seven per cent., Cleveland Museum of Health and Hygiene and Oberlin College, each five per cent., the Allen Memorial Medical Library, three per cent.,

and Berea College, Berea, Ky., one per cent. A separate fund will be in trust for each of these institutions. It is provided that sixty per cent. at least of all disbursements be made in the State of Ohio.

IT is reported in *The Times*, London, that a new organization, the Council for the Promotion of Field Studies, was formed at a recent meeting, held at the British Museum (Natural History) South Kensington, attended by representatives of universities, scientific societies and other bodies in many parts of the country. Professor F. E. Fritsch presided, and the proposal for the establishment of the council was put forward by F. H. C. Butler, who explained that support for the scheme had been promised by the Board of Education and the Scottish Education Department as well as by a number of learned societies. He suggested that the existing facilities for the study of natural history at first hand needed to be much improved, and that the best method of doing this would be to create a certain number of hostels for field studies in appropriate localities, each under a trained warden.

ACCORDING to *Nature* at the sixth meeting of the Conference of Ministers of Education of the Allied Governments held at the offices of the Board of Education last October, it was agreed to establish an Inter-Allied Bureau to carry out the practical steps needed to restore educational services in the countries concerned. This bureau will be the executive body of the conference. The work to be undertaken by the bureau includes the purchase and distribution of books and periodicals, the preparation of films and other visual aids and the supply of scientific equipment. These matters are at present being considered by commissions of the conference. The bureau was also asked to consider financial needs and methods of contribution by governments and the establishment of an inter-allied secretariat.

The Times, London, under date of December 16, writes: "Mr. Attlee, who was accompanied by the Chancellor of the Exchequer, Sir William Jowitt, and Lord Cherwell, received an influential deputation from the Parliamentary and Scientific Committee. The purpose of this deputation, which was led by Lord Samuel, was to urge the government to give more direct encouragement to scientific and technical training and research as an essential part of the plans for promoting industrial reconstruction after the war. E. W. Salt, chairman of the committee, specifically asked that the universities should be given an additional grant of £1,000,000 for the extension of research and training facilities; and that the Government should allot a day for a House of Commons debate on science and the future of industry." Mr. Attlee, replying, said that, although he could not anticipate the budget, he believed the Treasury was "sympathetically inclined," and that plans for science, both fundamental and applied, held a high place in the minds of all members of the Government.

DISCUSSION

THE DIRECTION OF ROTATION IN SPIRAL NEBULAE

IN SCIENCE for May 9, 1941, appeared a noteworthy abstract of a paper given before the National Academy of Sciences, under the above title, by the joint authors, Drs. Hubble and Mayall. Because of my early work on the radial velocity and the rotation of spiral nebulae I quite naturally have since been keenly interested in later observations in this field.

Their paper itself seems not to have been published and this abstract unfortunately lets the work appear something of a tour de force in science and could give the reader the impression that in astronomy we are drawing broad conclusions from narrow premises. In particular, the authors' statements that this is ". . . the first unambiguous determination of the direction of rotation of a spiral nebula" and that ". . . of the 1,000 brightest nebulae . . . only one system, NGC 3190," was found suitable to decide the direction of rotation, are too enthusiastic and too sweeping in their implications.

This "first unambiguous determination" is not the first, for it only confirms the winding-spring-like rotation of spirals that was well established twenty-six years ago, at Lowell Observatory, with a more powerful spectrograph;[1] a determination based upon the observation not of one but of several selected nebulae, some of which are among the best known and most suitable in the sky; and included a particularly searching study of the great Andromeda nebula because of its supreme fitness for affording decisive evidence on the direction of spiral rotation. Moreover, this early study of rotation of spiral nebulae followed a decade of similar work of mine on the rotations of the planets which had developed effective means and methods—not yet superseded—that have been advantageous in the study of rotation in the spirals.

In his more recent extended paper in the *Astrophysical Journal* for March, 1943, Hubble includes four of my early nebulae among the first eight of his list of "Well-observed Nebulae," and confirms and ac-

[1] *Proc. Am. Phil. Soc.*, 56: 403, 1917; and *Lowell Obs. Bull.* No. 80, 1917, etc.

cepts the judgment made by me in 1917, namely, that the spiral nebulae rotate in the direction of the arbor of a spiral spring that is being wound up; in his new words "they trail their arms."

V. M. SLIPHER

LOWELL OBSERVATORY,
FLAGSTAFF, ARIZ.

THE PERFUSION OF RAT LIVERS

J. SCHILLER and G. PINCUS report in the November 5 issue of SCIENCE on the "perfusion of rat livers with estrogen in vitro."

In Table 1, page 412, they present data which they interpret as controverting the findings of Heller and Zondek. Upon analyzing their data, however, we find them to be entirely in accord with our concepts of estrogen inactivation as set forth in *Endocrinology*, 32: 64, 1943, and *Endocrinology*, 26: 619, 1940.

(1) Their failure to find hepatic conjugation of estrogens is wholly in agreement with our findings that this mechanism for metabolizing estrogens plays an insignificant role in estrogenic inactivation.

(2) They find that amounts of α-estradiol as large as 208 r. u. are completely inactivated by perfusion through the liver in a period of 3 hours. Only a small percentage was recovered when as much as 300 r. u. was perfused through the liver, whereas 90 per cent. was recovered when 300 r. u. was perfused through the heart for a similar period of time. If the 208 r. u. of α-estradiol had been converted to estrone or estriol by the liver, as postulated by these authors, measurable activity should have been obtained from the perfusate. The fact that they found none beyond the amount found in control perfusate experiments to which no estrogen had been added is in keeping with our data that α-estradiol is destroyed by the liver when present in small or physiological quantities. Our own experiments indicate that the destruction is accomplished with the aid of an oxidative enzyme system.

(3) When they used very large amounts (3200 r. u. in the perfusate) one third of the activity was recovered. Their data obtained through fractionation experiments are unclear, since calculation of the estrogen fractions in terms of weight shows a recovery of 650 γ (50 γ as estradiol, 400 γ as estrone and 200 γ as estriol) when only 400 γ of α-estradiol had been added to the perfusate originally. However, their biological data, showing recovery of one third of a massive dose of 3200 r. u., fit in with our concept that "the liver and kidneys have a definite threshold capacity for oxidizing α-estradiol. Any amount above the threshold will escape oxidation. . . . At least two mechanisms for dealing with estrogen occur in the body, (*a*) an oxidative mechanism which inactivates the greater part of *physiologically* circulating estrogens, and (*b*) an overflow mechanism which operates mainly after liver oxidative capacity is reached. . . ." We also conceded that this overflow mechanism involved conjugation of free estrogens or transformation of one estrogen into another.

The data these authors present thus confirm the results of our experiments, although the conclusions they reach from their own data "controvert" our findings.

CARL G. HELLER

WAYNE UNIVERSITY

ANTHRACITE COAL ASHES FOR ROOTING CUTTINGS

A NOTE in SCIENCE,[1] of a few months ago, suggested to victory gardeners the use of sifted anthracite coal ashes to improve the texture of heavy clay soils. May I suggest another use for this material?

My father, who operated a successful wholesale cut flower business for many years in New York City, found during his later years that sifted hard coal ashes from the furnaces used to heat his greenhouse were excellent for the propagation of cuttings of chrysanthemums, roses, bouvardia, etc. Damping off was unknown in his cutting beds and mortality from other causes was very low. In addition, cuttings developed a fine ball of roots, and showed an exceptional vigor which the plants retained to maturity. No soil treatment was ever found necessary, water retention was adequate and aeration was excellent.

MILDRED P. MAULDIN

SOIL CONSERVATION SERVICE SEED
TESTING LABORATORY,
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JOULE AGAIN

LETTERS covering three fourths of p. 602 in the November 20, 1943, issue of *Nature* make desirable a restatement of what was said in SCIENCE in the issue of January 20, 1933: In the summer of 1897, while being conducted through the Physics Laboratory of the University of Edinburgh by Professor P. G. Tait, I chanced to ask him how we should pronounce the name of the physicist Joule. He smiled and said, "Well, I used to work with him and I can only say that he always called himself Joule," sounding the *ou* as in *you*.

Soon after the publication of this communication of mine in SCIENCE, Sir D'Arcy W. Thompson, of the University of Aberdeen, wrote me a letter from which I take the liberty of quoting: "You are perfectly right. The matter is not in doubt. *Joule* (*ou* as in *you*) is the great man's name, and every English physicist from Kelvin and Tait downwards—or onwards—has always called him so."

[1] SCIENCE, January 8, 1943.

Yet the latest edition of Webster's Dictionary persists in making Joule rhyme with jowl, and the Standard Dictionary gives the preference to this pronunciation.

In time, I presume, the editors of those two dictionaries will concede that Joule knew how to pronounce his own name.

JOSEPH O. THOMPSON
AMHERST COLLEGE

SCIENTIFIC BOOKS

BIOPHYSICS

An Introduction to Biophysics. By OTTO STUHLMAN, JR. 375 pp. 155 figures. New York: John Wiley and Sons, Inc. $4.00.

THIS book on biophysics was written to serve the needs of students in biology who have had one year of college mathematics and one year of college physics. The treatment of the subjects is sufficiently clear and restricted so that a student with the above preparation should have little difficulty in reading the book. The author has exercised admirable restraint in terminating his treatment of a subject before reaching the more complex aspects and has avoided the excessively descriptive treatment characteristic of biological subjects. The treatment of subjects ranges from mere descriptions of applications of physical instruments to attempted interpretations of biological processes in terms of the principles of molecular physics.

One objective in writing such a book should be to reveal the scope of biophysical investigation. This the book does well, since the chapters include discussions of cell membranes and surfaces, of properties of nerves and the special sense organs, of the action and use of various radiations and radioactive materials, and, finally, a description of the principles and uses of the compound microscope and the electron microscope. This array of subjects, though not exhaustive, serves well to illustrate the application of physical principles, methods and instruments in the solution of biological problems.

A second objective, of great importance in a first course in any science, should be to reveal or formulate a logical structure of the subject-matter. In a textbook this can be achieved not only by choice of material but by the order of presentation of this material. From this viewpoint the book is deficient because the arrangement of chapters is dictated largely by the divisions of classical physics rather than by the systematic development of a science of biophysics. Thus the first four chapters deal with some aspect of radiation in relation to organisms. Chapter one is about x-rays, chapter two deals with radioactivity, chapter three with the properties of the eye, and chapter four discusses the emission and absorption of light by biological materials. The field of chemical or molecular physics is represented to some extent by chapter five on the properties of surfaces and membranes. Chapter six is primarily about the electrical properties of nerve; sound and auditory mechanisms are taken up in chapter seven. The last chapter is a discussion of the properties and use of the compound microscope and the electron microscope. Thus are represented most of the usual divisions of physics: radiation, molecular physics, electricity and sound.

This text structure is an unfortunate one, since it has no logical order which defines the field of biophysics as a unique scientific approach to the interpretation of living processes.

However, the order of presentation of material can be rearranged, since understanding of the content of any one chapter of the book does not depend in any important way upon that of other chapters. Therefore, this book could be used to advantage even in a course organized for the purpose of giving the student an impression of a logical science based on the principles of biology and physics. In such a course the chapters dealing primarily with physical instruments and methods could be brought in as a group representing the methodology of biophysics. The limited material directly relating to cells and organisms in chapters one, two and four could be discussed in relation to cellular mechanisms rather than physical methodology. The latter is extremely important to the subject and should never be omitted. It should not, however, define the organization of material contained in a course in biophysics.

Although it may be questioned whether this book adequately represents the scope of biophysics as a distinct science, it will be a very useful adjunct to a course in physics designed for students in pre-medical and biological fields.

FRANK BRINK

POTASH

Potash in North America. By J. W. TURRENTINE. 6×9 in. 186 pp. Illustrated. New York: Reinhold Publishing Corporation. 1943. $3.50.

ABOUT sixty years have passed since potash fertilizers in this country were first prepared from inorganic sources. During the first half of this period the entire supply was imported from Germany. The disadvantages of dependence on a foreign source for such an essential commodity was repeatedly stressed, and the demand for a domestic source of supply increased with increase in consumption of potash in fertilizers. With a view to meeting this demand, Con-

gress in 1911 made a specific appropriation for the Bureau of Soils, U. S. Department of Agriculture, for "exploration and investigation within the United States to determine a possible source of supply of potash, nitrates and other natural fertilizers." At the same session in 1911, the Geological Survey was authorized to make exploratory borings to determine the possible existence of potash deposits within the United States. In 1916 another item was added in the appropriation act for the "investigation and demonstration within the United States to determine the best method of obtaining potash on a commercial scale."

The book under review is the second of a series of two books by the same author describing the research, exploration and development work on potash that followed the enactment of these appropriation acts. The first of these two books entitled "Potash: A Review, Estimate and Forecast," covers the period 1911 to 1926. The second of the series begins where the first left off and covers the fifteen-year period following 1926. The first chapter reviews the progress that has been made in the production of potash during this period in various countries of the world as well as in the United States. It reviews also the purposes and activities of the American Potash Institute, which was organized in 1935. The second chapter outlines the uses of potash in agriculture and in the chemical industries and gives statistical data on American and World Trade in potash salts between 1926 and 1941. In the third chapter detailed information is given on the technology of potash production at Searles Lake and in the New Mexico field.

This book is one of the American Chemical Society Series of Scientific and Technologic Monographs and it is in keeping in every respect with the high standards set by the society for this series of publications. The author is recognized as having taken a leading part in all research and development work on potash since this was first undertaken in 1911. The present book, as with the first of the series, can, therefore, be recommended without reservation to those who are interested in securing the most authoritative information available on the history and development of the American potash industry.

WILLIAM H. ROSS
DIVISION OF SOIL AND FERTILIZER INVESTIGATIONS,
U. S. DEPARTMENT OF AGRICULTURE,
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SPECIAL ARTICLES

THE DISINTEGRATION OF MACROMOLECULAR TISSUE LIPOPROTEINS[1]

THE thromboplastic protein (inducing the formation of thrombin) isolated by the ultracentrifugal fractionation,[2] or, in considerably less pure form, by the fractional salt precipitation[3] of beef lung extracts is a macromolecular lipoprotein. As has been described previously,[2] preparations may be obtained under proper conditions that exhibit homogeneity of sedimentation and electrophoretic mobility, have the extremely high particle weight of 170 million (from rate of sedimentation), and appear in electron micrographs as spheres with a diameter of 80 to 120 mμ. Apart from their extremely high thromboplastic potency (as little as 0.008γ being demonstrable by clotting tests), these preparations were distinguished by a marked phosphatase activity.

The thromboplastic protein of beef lungs resembles in certain outward respects, *e.g.*, its analytical composition and content of acetal phosphatides, the submicroscopic particles isolated from a number of tissues.[4] As is true of most natural lipoproteins,[5] the lipids forming part of the thromboplastic protein[3, 6] are held vigorously and can be removed only by exhaustive extraction with alcohol-ether which renders the protein moiety insoluble and inactive.

It was recently shown by McFarlane[7] that a large proportion of the serum lipids, ordinarily not extractable with ether, may be transferred into the ether phase, when ether-containing serum is frozen below −25° and allowed to thaw. The application of a similar technique to the thromboplastic protein and other lipoproteins gave interesting results.

In a typical experiment, summarized in Table 1, a solution of 330 mg of the thromboplastic protein in 15 cc of borate buffer of pH 8.5 was mixed with 10 cc of ether (free of peroxides and alcohol), kept for 4 minutes at −30°, and permitted to thaw. This operation was, after replacement of the ether layer by fresh solvent, repeated six times. From the aqueous phase, freed of the remaining ether by careful evacuation, a large proportion of the protein could be isolated by centrifugation at a low speed as Fraction A which exhibited somewhat higher thromboplastic and phosphatase activities than the original material. A small amount of practically unaltered thromboplastic

[1] This work has been supported by a grant from the John and Mary R. Markle Foundation.
[2] E. Chargaff, D. H. Moore and A. Bendich, *Jour. Biol. Chem.*, 145: 593, 1942.
[3] S. S. Cohen and E. Chargaff, *Jour. Biol. Chem.*, 136: 243, 1940.
[4] A. Claude, SCIENCE, 97: 451, 1943.
[5] E. Chargaff, "Advances in Protein Chemistry," vol. 1, 1944 (in press).
[6] S. S. Cohen and E. Chargaff, *Jour. Biol. Chem.*, 139: 741, 1941.
[7] A. S. McFarlane, *Nature*, 149: 439, 1942.

TABLE 1

DISINTEGRATION OF THROMBOPLASTIC PROTEIN BY FREEZING IN PRESENCE OF ETHER

Fraction	Centrifugal characteristics: Duration of centrifugation	Centrifugal force	Sedimentation	Electrophoretic characteristics*: Mobility	Area	Proportion of starting material	N	P	Thromboplastic activity†	Phosphatase activity‡: Phosphatase units per mg	Initial activity per mg
	min.	*g*		*($u \times 10^5$)*		*per cent.*	*per cent.*	*per cent.*	*γ*		*A100*
Thromboplastic protein	30 90	5,000 31,000	No Complete	7.59	100		7.6	1.6	0.008	1.56	4.49
A	30	1,900	Almost complete			50.4	8.3	1.4	0.003	2.73	5.58
B	30 90	1,900 31,000	No Complete			7.5	8.1	1.5	0.008	2.91	4.36
C	90	31,000	No	3.34 6.55 8.07	25 46 29	15.8	12.1	0.70	Inactive up to 6γ	2.02	4.52
D (Control experiment)	30 90	1,900 31,000	No Almost complete			98.1	7.2	1.6	0.003	0.9	1.83
E (Control experiment)	90	31,000	No			1.7			0.03	0.7	1.20

* The experiments were carried out in borate buffer of pH 8.5. The computation of mobilities and relative areas is based on the descending boundaries.

† Expressed as smallest amount clotting 0.1 cc of rooster plasma within 30 minutes. The experiments were carried out at 30.6° by mixing 0.1 cc of fresh rooster plasma (normal clotting time above 80 minutes) with 0.03 cc of the solution of the protein in borate buffer, pH 8.5.

‡ The determinations were carried out in the presence of Mg ions. For the experimental arrangement and the definition of the units, compare.[2]

protein could be separated by high-speed centrifugation (Fraction B). The supernatant then was found to contain a considerable proportion of a mixture of non-sedimentable proteins (Fraction C) which, while quite active as phosphatase, was devoid of thromboplastic activity. A lipid fraction (rich in acetal phosphatides) amounting to 18 per cent. of the starting material, *i.e.*, roughly one third of the total lipids of the thromboplastic protein, was recovered from the combined ether extracts. A control experiment carried out simultaneously with the omission of ether failed to reveal an appreciable aggregation or disruption of the protein or other gross changes due to the freezing: the sedimentation of the protein (Fraction D), almost negligible at 1900 g, became practically complete at 31,000 g. The supernatant contained only traces of protein (Fraction E). Fraction D showed a higher thromboplastic and a lower phosphatase activity than the untreated protein; but this effect of freezing on the phosphatase potency was not observed to that extent with other preparations.

The view of the structure of lipoprotein complexes, based on x-ray evidence, as thin protein layers inserted between bimolecular lipid leaflets,[8] appears to permit the assumption that these units could arrange in a regular manner to form large complexes whose size would perhaps be limited by the intracellular spaces in which their formation takes place. The importance of the lipids in maintaining uniformity of particle size and electrophoretic mobility could thus be understood. The isolation of a fraction (consisting of three electrophoretically distinct components) having marked phosphatase, but no thromboplastic activity (Fraction C) is indicative of the far-reaching changes produced by even the partial removal of the lipids from the ostensibly homogeneous complex, once the protective water barrier is frozen away. It should be of interest to apply this technique to some of the animal viruses which, as isolated from infected tissues, are reported to occur in form of, or attached to, lipoproteins of very high particle weight.

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[8] K. J. Palmer, F. O. Schmitt and E. Chargaff, *Jour. Cell. and Comp. Physiol.*, 18: 43, 1941.

THE OPTICAL ROTATION OF CELLULOSE AND GLUCOSIDES IN CUPRAMMONIUM HYDROXIDE SOLUTION

THE high (levo) optical rotation of cellulose in cuprammonium hydroxide solution is believed to be a property of a complex formed by a copper-containing radical and free hydroxyl groups of cellulose. Neither the composition of the copper radical nor the points of its engagement with cellulose have been known with certainty. The following experiments (Table 1) show that complexes of similar high rotation are formed when appropriately substituted simple glucosides are dissolved in cuprammonium hydroxide solution. The levo-rotatory complex appears to be a cyclic structure involving hydroxyl groups on glucose carbon atoms

2 and 3. This conclusion is in agreement with the speculations of others regarding the structure of the copper-cellulose complex.[1] The formation of a highly levo-rotatory complex does not require that the glucosidic units be linked together in a polysaccharide.

β-Methyl glucoside dissolved in cuprammonium hydroxide solution does not show a levo rotation. However, β-methyl-4-methyl glucoside, which possesses the same free and substituted positions as cellulose, shows optical activity remarkably like that of cellulose. Similar behavior is exhibited by α- and β-methyl glucosides substituted in positions 4 and 6. In these cases only hydroxyl groups on positions 2 and 3 are available for engagement with the copper radical.

When positions 2 and 4 of a methylglucoside are substituted the levo-rotating complex is not formed, indicating that a free hydroxyl group on position 2 is essential for the complex formation. Likewise when positions 3, 4 and 6 are substituted the levo-rotatory complex is not formed indicating that a free hydroxyl group on position 3 is also essential. Formation of the levo-rotatory complex in glucopyranosides appears to require that hydroxyl groups on carbon atoms 2 and 3 be free while that on 4 must be substituted. It is immaterial whether position 6 be free or substituted. Finally the possibility that the complex involves linkage of the 2 position of one glucoside molecule with the 3 position of another was investigated. A solution containing equal parts of 2,4- and 3,4,6-substituted glucosides dissolved in cuprammonium hydroxide solution showed no indication of complex formation.

All the glucose derivatives considered in this communication are believed to have the pyranoside structure. Since the magnitude of the optical rotation in cuprammonium hydroxide solution is dependent upon the relationship between concentration of copper and carbohydrate, all observations were made on approximately 0.03 Molar glucoside solutions or 0.5 per cent. cellulose solutions. Aqueous solutions of similar concentration were employed. A description of the synthesis and properties of β-methyl-3-methyl-4,6-ethylidene glucoside as well as observations on the optical rotation of other polysaccharides and substituted glucosides will be published in another communication.

TABLE 1

THE OPTICAL ROTATION (Hg BLUE LINE) IN WATER AND CUPRAMMONIUM HYDROXIDE SOLUTION OF CELLULOSE AND SOME METHYLGLUCOSIDES*

Substance	Solvent†	$[\alpha]_{436}^{25}$	$[M]_{436}^{25}$
Cellulose (Purified cotton fiber)‡	Cupra	−1200°	−194,400°
	Water-Triton B(1:1)	− 46°	− 7,500°
		Dif.	−186,900°
β-Methyl-4-methyl glucoside	Cupra	−1008°	−209,700°
	Water	− 36°	− 7,500°
		Dif.	−202,200°
β-Methyl-4,6-ethylidene glucoside	Cupra	−1058°	−234,800°
	Water	− 163°	− 36,200°
		Dif.	−198,600°
α-Methyl-4,6-benzylidene glucoside	Cupra	− 608°	−171,500°
	Water	+ 159°	+ 44,800°
		Dif.	−216,300°
β-Methylglucoside	Cupra	+ 67°	+ 13,000°
	Water	− 62°	− 12,000°
		Dif.	+ 25,000°
α-Methylglucoside	Cupra	+ 432°	+ 83,800°
	Water	+ 306°	+ 59,400°
		Dif.	+ 24,400°
α-Methyl-2,4-dimethyl glucoside	Cupra	+ 275°	+ 61,000°
	Water	+ 308°	+ 68,400°
		Dif.	− 7,400°
β-Methyl-3-methyl-4,6-ethylidene glucoside	Cupra	− 128°	− 30,200°
	Water	− 126°	− 29,700°
		Dif.	− 500°

* The Hg blue line (436 mμ) was isolated for aqueous solutions by use of Corning filters 511 and 038. For cuprammonium solutions it is only necessary to use filter 038 since the longer wave-lengths are absorbed by the solution.

† The cuprammonium hydroxide solution contained 15 gm. copper, 240 gm. ammonia, and 1 gm sucrose per liter. All observations on cuprammonium solutions were made in an 0.5 dm tube. The rotation of the solvent was +0.09° (0.5 dm).

‡ It is impossible to give a correct figure for the rotation of cellulose in water solution. The present value was obtained by dissolving acid-treated cotton fiber in Triton B and diluting with an equal volume of water. Triton B is an aqueous solution of trimethyl benzyl ammonium hydroxide supplied by Röhm and Haas Company, Inc.

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[1] "Natural and Synthetic High Polymers," p. 291. By Kurt H Meyer. Interscience Publishers, Incorporated, New York, 1942.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A STILL FOR THE CONTINUOUS PRODUCTION OF DOUBLE DISTILLED WATER

THIS apparatus has been used for the production of all-glass distilled water for over a year and has proved very efficient. The water level in the distilling flask is maintained by means of a simple float valve made from a cork and a rectangular brass rod about 1 cm wide and 2 mm thick. This is faced at one end with a piece of gum rubber about 3 mm thick. A weather-stripping cement[1] is used to fasten the rubber to the brass. This is hinged so that when the large cork is horizontal the inlet tube (a quarter inch brass tube) is closed. The box *A* for the leveling device is made from ⅛ inch brass plates. The distillation flask

[1] 3 M weatherstrip cement sold by Minnesota Mining and Manufacturing Company, St. Paul, Minn.

E is made from a Pyrex 2 liter flask which has a 24/40 ground glass joint *D* sealed into it. The tubing sealed into the male part of the joint should be constricted slightly at the bottom and turned up to prevent the ingress of air bubbles during boiling. The siphon is equipped with an air trap. It is made by sealing a side arm into the bulb of a broken 10 ml pipette; the upper part of the bulb is sealed. The siphon tube should be sloped from the bulb into the flask so that if any bubbles form they will collect in *B*. Over a period of months only a small amount of air collects in *B*. The rubber tubing *C* should permit the insertion of a clamp when the apparatus is not in use. The soda lime tube *F* should contain only coarse particles; otherwise it offers too much resistance to the distillation and may blow the stopper out of the flask. Sometimes it is advisable to remove the soda lime tube during the distillation.

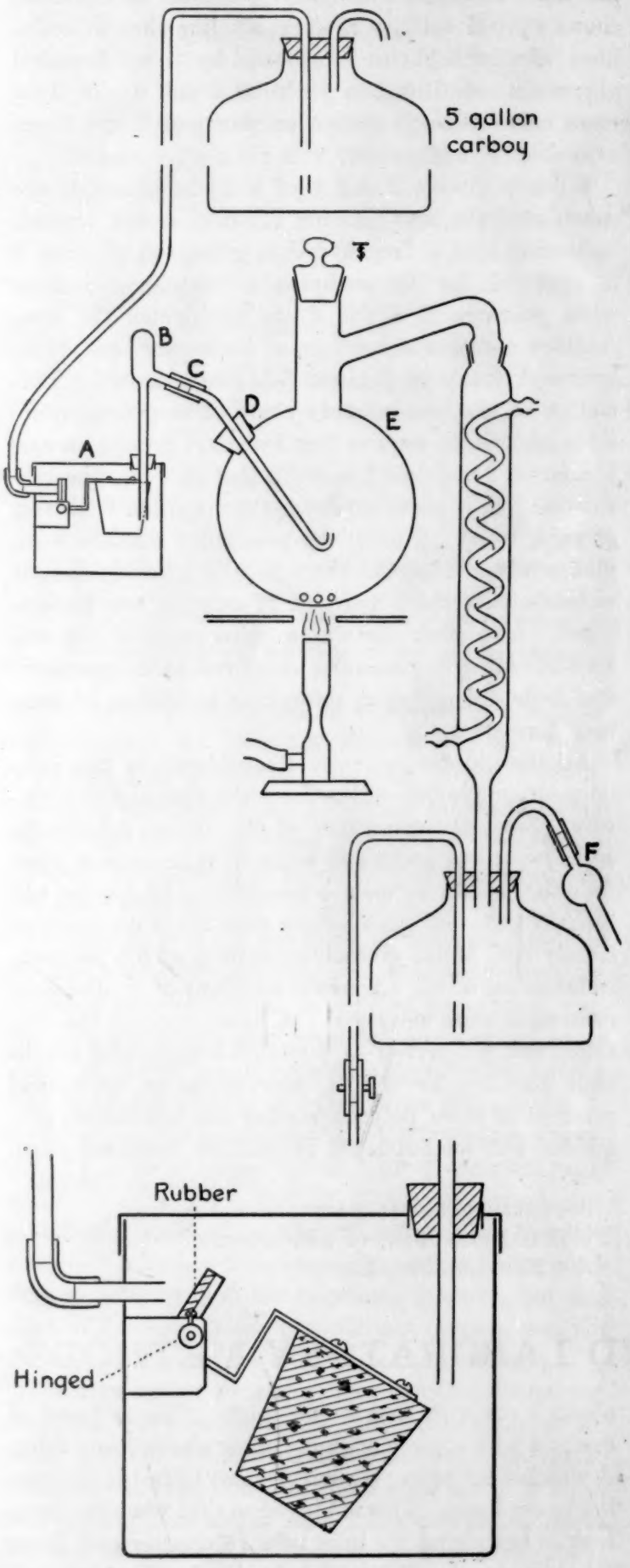

FIG. 1

Two mls of 85 per cent. phosphoric acid and a few glass beads are put into the flask. A Day pinch clamp is left on the rubber tubing at *C* until the water starts to boil. The siphon can be filled from the rubber tubing on the end of the delivery tube from the large carboy. When the siphon and the air trap *B* are filled, the clamp is put on at *C*. When the first distillation is started the flask *E* should be filled to a level a little below that in *A;* otherwise when the water starts to boil it will force some of the solution out of the flask into the leveling box.

The entire apparatus can be assembled in an area $24 \times 15 \times 65$ inches, which includes a 5-gallon carboy reservoir for single distilled water. Where there is a supply of running distilled water, a line can be brought over to the 5-gallon carboy and so facilitate filling the reservoir. The carboy rests on a shelf supported by wall brackets and a $\frac{3}{4}$ inch pipe which serves as a support for the rest of the equipment.

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